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Components of Attention in Synesthesia

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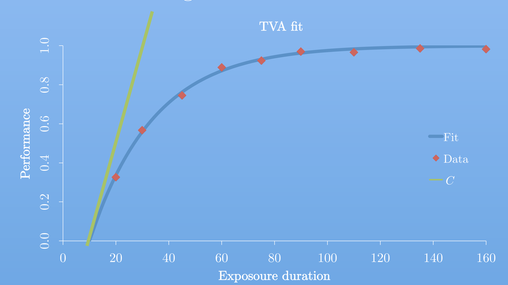
Abstract

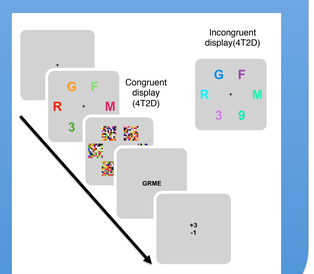
One of the most common forms of synesthesia is between colors and graphemes (Colizoli, Murre, & Rouw, 2012). Numerous studies have investigated different aspects of attention and synesthesia, e.g. effects of Stroop-like interference by colors that are incongruent with the synesthetic experience. Here we attempt to isolate how specific components of attention are affected by grapheme-color synesthesia. Eight carefully screened healthy participants with synesthesia reported the letters in briefly presented, post-masked arrays of letters and digits. On half the trials, the letters and digits were presented in colors congruent with the synesthetic experience. On the other half of the trials, the letters and digits were presented in colors that were incongruent with the synesthetic experience. Components of attention were estimated separately for congruent and incongruent trials by fitting the data to a mathematical model based on A Theory of Visual Attention (Bundesen, 1990). It has previously been demonstrated that color experiences in observers with synesthesia are very stable over time, and that the color experience seems to be an integrate part of the processing of letters, in for example grapheme-color synesthesia (Mattingley, 2009). Results from the present experiment show that synesthesia affects both speed of processing (C) and the number of objects that can be retained in visual short-term memory (K).
Participants were faster at encoding characters that were colored congruently with their synesthesia. In addition, the capacity of the visual short-term memory increased slightly in the congruent compared to the incongruent condition. Interestingly, congruent trials compared to incongruent trials did not seem to afford benefits to attentional selectivity (α), nor did they affect the threshold for visual perception (t_0). The results, therefore, indicate that synesthesia relates to a specific subset of attentional components.

Attention

To measure specific components of attention a Theory of Visual Attention (TVA; Bundesen 1990) was used. Hereby we are able to estimate the threshold for visual perception ($t0$) at the intercept of the fitted curve on x. The speed of processing (C) is estimated by the slope of the tangent in t_0, and the capacity of visual short-term memory (K) is measured as the asymptote of fitted curve. Finally, the efficiency of selection (α) can be described as a ratio between targets and distractor elements.

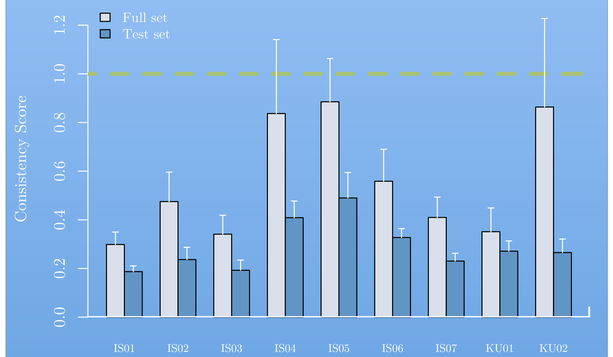


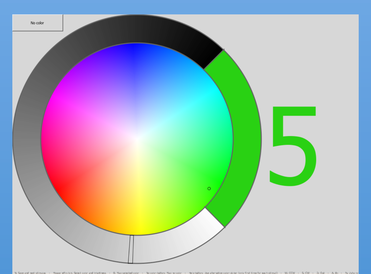
Using a partial report (Sperling 1960), observers where to report the identity of letters and suppress numerical distractors. The coloring of the stimulus display would either be congruent or incongruent varying randomly in each trial.



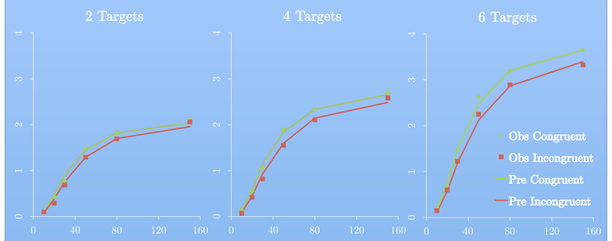
Synesthesia

Nine participants (19-39, 7 female) were screened using a screening tool inspired by Eagleman, Kagana, Nelson, Sagaram, & Sarma (2007), cutoff marked by the green line. Consistency was measures for both letters and numbers in each participant, and a subset of the most consistent letters (12) and numbers (6) was used in the experiment.





Results



	C		K	
	Congruent	Incongruent	Congruent	Incongruent
Average	103.627	83.768	3.778	3.547
St. dev.	35.121	25.327	0.708	0.597
P	0.003		0.006	

The parameters of the nine color-grapheme observers in the congruent and incongruent trials showed that both processing speed and short-term memory capacity is affected by the two different conditions.

	t_0		α	
	Congruent	Incongruent	Congruent	Incongruent
Average	11.849	12.747	0.570	0.538
St. dev.	6.501	6.846	0.217	0.183
P	0.303		0.654	

Whereas both target selection efficiency and the threshold for visual perception remained unaffected by whether the stimulus was congruent with the synesthetic experience or not.

Conclusion

Observers with color-grapheme synesthesia both have a faster processing speed and a higher capacity for stimuli presented in a congruent compared to an incongruent condition
However, both the threshold for visual perception and the efficiency of target selection seem to be unaffected by a manipulation of stimulus congruence or incongruence.
This indicates that a focus on the specific attentional components of synesthesia is important for understanding the mechanisms of color-grapheme synesthesia